

Invisible Zombie Wildfires

Peat fires are endangering
lives and the environment –
and they are spreading

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"Peatlands store a lot of carbon, so they are very important, not only for tropical countries like Indonesia, but around the world."

Prof. Yulianto Nugroho Professor of Mechanical Engineering, University of Indonesia, Indonesia

"Peat fires are not just a problem for Southeast Asia. With climate change heating up the planet, they are also becoming a problem in the northern latitudes like Canada, Russia and northern Europe."

Prof. Guillermo Rein Professor of Fire Science, Imperial College London, UK

Challenge

- Peat fires can smoulder invisibly underground. They release toxic gases and large quantities of carbon into the atmosphere, which accumulate near the Earth's surface and pose a serious risk to human well-being.
- There is limited knowledge about how these fires start, spread, and, importantly, how to put them out.
- Peatlands are found worldwide, and many are drying out due to climate change and human development. These conditions make them susceptible to fire, including previously water-logged peatlands in the Arctic.
- Research into peat fires is making it possible to identify these invisible toxic fires, predict their ignition, and ultimately extinguish them.

The Context

Thick layers of carbon-rich soil known as peatlands cover about 3% of Earth's land, and contain about a third of global soil carbon¹. That is twice the amount that is found in the world's forests¹. This soil – the result of decayed plants that have accumulated over thousands of years – is usually waterlogged or found in cold areas, such as the Arctic.

But climate change and human development are drying out peatlands or, in the case of northern latitudes, heating them up. When they are dry, they become fire risks. In 1997, peat fires in Southeast Asia released up to 2.57 billion metric tons of carbon, which is equivalent to 40% of annual global emissions². Another blaze in 2015 each day released the equivalent carbon dioxide as the fossil fuels used by the European Union daily³. Smouldering peat releases ancient carbon that has not been part of the global carbon cycle for centuries⁴.

Unlike traditional wildfires with their tall flames and billowing smoke, dry peat smoulders making it difficult to detect and extinguish the fire. They are sometimes called 'Zombie Fires' because they appear to die out, but continue to burn underground and later reignite aboveground.

These fires can last for weeks or even months, creating a haze that can envelop entire regions. The 1997 Indonesian peat fire's haze covered large parts of the region, extending as far as China and Australia. The low-hanging smoke pushed a spike in respiratory illness among those living in affected areas⁵. The invisible fires can also give rise to large sinkholes, when the peat underneath the ground has burned away.

Peat fire suppression is tricky, given the location of the burning peat and the difficulty in getting water to the area. Consequently, many of these fires burn until the rainy season comes⁶. Dousing them with water tends to create channels underground, which circumvent the smouldering hotspots. It can take billions of litres of water to douse a peat fire⁴.

Imperial College London researchers and their collaborators study peat fires in environments from Indonesia to Scotland, working with policymakers and local partners to predict and extinguish them. Through its HazeLab, which specialises in fire studies, the university hosts international students and researchers to support a two-way exchange of knowledge and improve global understanding of peat fires.

"The field trials have given us real knowledge on how we should maintain the moisture content of peat – and how the fires can spread."

Prof. Yulianto Nugroho Professor of Mechanical Engineering, University of Indonesia, Indonesia

"It's not only the policymakers who have responsibilities to control peat fires – it's also academics, researchers and communities."

Dr. Hafizha Mulyasih, Research Associate in Fire Science, Imperial College London, UK



Method

Peat fires are complex, long-lived disasters that demand equally sophisticated solutions. Imperial College London and its partners in Indonesia and Singapore have developed an integrated toolbox – from field studies and lab experiments to predictive models and underground fire detection – that helps authorities manage peat fires and protect affected communities.

- In 2018, ICL researchers and Indonesian colleagues ran field trials in peatlands to understand what causes ignition, how peat fires spread, and how to suppress them. It was the largest and longest to-date field experiment of peat wildfires, conducted in a degraded peatland of Sumatra, Indonesia⁶.
- A laboratory study, conducted by researchers from ICL and Universitas Indonesia, showed the efficacy of an environmentally friendly peat fire suppressant⁴, which is already used on wildfires. When combined with water, their suppressing agent reduced the time required to extinguish the peat fire by 40%; they also did not need to use as much water.
- By applying their basic research into peat fires, ICL researchers and their collaborators have developed models⁷ that can predict when and where fires will start. Using peat moisture content to forecast the behaviour of peatland wildfires, successfully applying their model to a real peatland fire in Borneo in 2015. Allowing officials and stakeholders to predict their risk of peat fire.
- Imperial College London researchers and collaborators have created two technology pathways to identify invisible peat fires: one detects characteristic chemical signatures, and the other identifies the infrared signal of underground burning; this research is freely available.
- Analysis of smoke composition has enabled researchers to identify which face masks best protect civilians from toxic haze.
- A collaboration between Imperial College London and NTU Singapore produced educational videos to teach undergraduates about peat fires, their impacts, and restoration solutions.
- Two-way knowledge exchanges with collaborators and student co-supervision ensure the development of homegrown expertise in countries which struggle with peat fires.

"Because peat fires are difficult to detect, they are also difficult to suppress."

Dr. Hafizha Mulyasih Research Associate in Fire Science, Imperial College London, UK



Benefits

- **Peat-fire detection:** Through detection technology pathways, officials and stakeholders are better able to detect smouldering peat fires.
- **Risk prediction:** With ICL's peat fire models, officials and communities can determine their risk of peat fires
- **Technology transfer:** The Hazelab's research is freely available and empowers local industry and institutions to develop and innovate their own solutions to peat-fire detection and suppression.
- **Improved health:** Predicting and avoiding peat fires protects the health of local communities; similarly, identifying invisible fires empowers people to take action, such as wearing appropriate masks.
- **Co-creation:** Through partnerships with local officials and academics, peat fire research is addressing the gaps in knowledge in different contexts.
- **Capacity building:** Collaboration with local institutions ensures knowledge transfer and bolsters capacity on the ground to improve monitoring and decision-making.

Impact

- **For communities:** A better grasp of peat fires reduces the risk to communities. Noxious fumes from undetected smouldering peat are a serious health threat. Early identification and suppression also reduce the fires' carbon emissions and ultimately their contribution to climate change.
- **For researchers:** Increased peat fire knowledge enhances research into local or regional fires and soils. Scholars and stakeholders are able to adapt the research to their own context, where it can have greater impact, and strengthen their understanding of different ecosystems.
- **For decision-makers:** Improved monitoring and peat fire prediction would arm decision-makers with information to protect the health and livelihoods of the people they represent. Additionally, better methods to suppress fires could reduce their duration.

"We should recognise the importance of peatland ecosystems and look into how our actions and policies can stop the damage that is done to them or mitigate the harm."

Asst Prof. Janice Ser Huay Lee,
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Notes

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9. Image - By U.S. Fish and Wildlife Service Northeast Region - Smoldering peat fireUploaded by AlbertHerring, CC BY 2.0, <https://commons.wikimedia.org/w/index.php?curid=30924626>

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